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Chemistry. — *"On the Iodides of the Elements of the Nitrogen Group"*. By H. R. Doornbosch. (Communicated by Prof. P. van Romburgh).

(Communicated in the meeting of November 25, 1911).

§ 1. Frequent investigations have been carried out in regard to the iodides of the elements nitrogen, phosphorus, arsenic, and antimony, but these chiefly concerned the two first elements of this group.

So far as *nitrogen-iodide* is concerned, the question as to the existence of a *free* compound of the formula NJ_3, may now be answered in a negative sense.

As the result of the latest investigations as to this question, such as those of Chattaway [1]), Ruff [2]) and Hugot [3]), it is well nigh certain that NJ_3 can exist only in complex molecules with 12, 3, 2 and 1 mols. of NH_3, respectively, and then only at low temperatures.

Of *phosphorus*, two iodides are known ; according to the literature on the subject, the *di*-iodide P_2J_4 m.p. 110° (according to this research 124°), whose vapour under reduced pressure is said to deposit mainly PJ_3 with formation of red phosphorus:

$$6\ P_2J_4 \leftrightarrows 8\ PJ_3 + P_4,$$
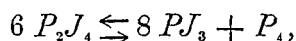
further the *tri*-iodide PJ_3 m.p. 55°—60° which is said to yield a dissociated vapour, but only at a higher temperature.

With arsenic on the other hand, it is only the compound AsJ_3, which is accepted with absolute certainty, as the statements [4]) as to As_2J_4 (analogous to the phosphorus compound) must in any case be considered to be of a doubtful nature, particularly so because Arzruni's crystal-measurements of these products do not admit of safe conclusions as to the individuality of the supposed compound. Whilst with the phosphorus, no derivative of the pentavalent element is described, some statement as to AsJ_5 are found in Sloan's paper [5]).

Of antimony we find in the first place a compound SbJ_3 described supposed to be isomorphous with BiJ_3. Van der Espt [6]) and afterwards Pendleton [7]) have noticed a compound SbJ_5 with a melting point of 78°—79°; the existence thereof has, however, been denied

[1]) Chattaway, Norton, and others, Amer. Chemic. Journ 23, 363, 369 (1900); 24, 138, 159, 318, 331 (1900).

[2]) Ruff, Ber. d.d. Chem. Ges. 33, 2025 (1900).

[3]) Hugot, Ann. de Chim. et Phys. (7), 21, 5 (1900).

[4]) Bamberger ond Philipp, Ber. d.d. Chem. Ges. 14, 2644 (1881).

[5]) Sloan, Chem. News, 46, 194 (1882).

[6]) Van der Espt, Arch. Pharm. (2), 117, 115 (1864).

[7]) Pendleton, Chem. News. 48, 97. (1884).

by Mac Ivor [1]), in whose opinion only one compound, namely SbJ_3 can exist.

This incompleteness of the statements in the literatue coupled with the experiences gained by Eggink [2]) with the chlorine-derivatives of the analogous *bismuth*, and the suspicion that a two-layer formation might occur also here as a confusing complication, caused Prof. Jaeger to suggest to me to investigate some of the disputable questions. We may, therefore, state briefly in this paper the results obtained in the study of the binary systems: $As + J$ and $Sb + J$, also of those of $AsJ_3 + PJ_3$, $SbJ_3 + PJ_3$ and of $AsJ_3 + SbJ_3$. Further details will be communicated later in a dissertation now in hand.

§ 2. *Antimony and Iodine.* The binary molten mixtures investigated, were prepared from SbJ_3 sublimed in a CO_2-current, with the aid of Sb or J_2. The fusion, in order to avoid loss of iodine by volatilisation, took place in the case of mixtures rich in Sb, in evacuated and afterwards sealed glass tubes. With the mixtures very rich in Sb the cooling- and heating-curves were also recorded in closed apparatus. In the tables are found, besides the actual temperaturereadings, also the corrected ones; the thermometers were compared with a certificated normal thermometer. By way of comparison, the solidifying- and the melting-points are given side by side, so as to point out the difference between the results of cooling- and heating-experiments. On account of the rapid setting in of the equilibrium, and the want of an appreciable undercooling, these differences are not large in this system.

From these determinations it is shown, that when the binary molten mixtures solidify, Sb and J form only *one* compound, namely SbJ_3. This compound has a sharp melting-point of 170°.8 C. It does not mix perceptibly with antimony; if more antimony is added than corresponds with the composition SbJ_3, the melt separates into two liquid layers of which the upper one differs but exceedingly little in composition from SbJ_3, whilst the lower one has the composition 71.6 at % Sb and 28.4 at % J, as proved by repeated analysis of suddenly cooled mixtures. The transition-temperature is 169° C.; at that temperature the liquid with 28.4 % of J, will, with deposition of Sb, form the layer whose composition practically does not differ from SbJ_3. As the eutecticum then following between that resulting layer and pure SbJ_3 practically coincides with 75 % of J, the inter-

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[1]) Mac Ivor, Journ. Chem. Soc. **29**, 328 (1876); Chem. News. **86**, 223.

[2]) Eggink, Zeits. f. phys. Chem. **64**, 449 (1908).

Binary melting-point-line of Sb + J.

% by weight		% by atoms		Observed temperature.		Corrected temperature.		Duration of the effect
Sb	J	Sb	J	Solidifying point.	mp.	Solidifying point.	mp.	in seconds.
100.	0.	100.	0.	630.$^{\circ}$	—	632.$^{\circ}$	—	—
89.5	10.5	90.	10.	163.4	165.8	166.5	168.9	130
79.1	20.9	80.	20.	164.1^5	—	167.2^5	—	230
75.	25.	76.	24.	165.8	167.2	169.0^5	170.4^5	330
70.9	29.1	72.	28.	165.9	167.2	169.0	170.3	380
58.7	41.3	60.	40.	165 5	167.	168.5	170.1^5	500
48.6	51.4	50.	50.	165.4^5	167.1	168.6	170.2^5	580
38.7	61.3	40.	60.	165.5	166.	168.4^5	168.9^5	630
28.9	71.1	30.	70.	165.2	166.8	168.1	169.7	780
24.0	76.0	25.	75.	167.1	167.6 End solidifying point.	170 3	170.8 End solidifying point.	—
23.4	76.6	24.4	75.6	160.8	77.9	164.4	78.7	300
22.7	77.3	23.6	76.4	154.9^5	79.2	158.3^5	79.7^5	420
20.5	79.5	21.5	78.5	144.8	79.4	147.	79.7	740
18.8	81.2	19.6	80.4	132.8	79.8	134.2^5	80.2	1040
16.5	83.2	17.3	82.7	116.	79.2^5	117.7	80.1^5	1220
14.2	85.8	14.9	85.1	95.3	79.3	96.5^5	80.2	1500
12.4	87.6	13.0	87.0	83.5^5	,79.3^5	84.4^5	80.2^5	1520
11.3	88.7	11.8	88.2	79.	79.2^5	79 8^5	80.·1	1700
10.7	89.3	11.2	88.8	81.1	79.2^5	82.0	80.1^5	1480
7.9	92.1	8.3	91.7	91.8^5	79.4^5	92.8^5	80.2	1080
4.3	95.7	4.5	95.5	102.4	78.3	103.7^5	79.1^5	720
0.9	99.1	1.0	99.0	110 8	76.8^5	1J1.8	77	210
0.	100.	0.	100.	112.1	—	113.3^5	—	—

vals superpose each other. Hence, the abnormal course of the time line.

The melting point of iodine (113°.3 C.) is lowered by addition of SbJ_3 and the eutectic point appears to lie at 80° C. and a content of 88.2 at. $^{\circ}/_{0}$ of iodine. From the fact that the eutectic separation is found quite close to the vicinity of the pure iodine, it follows, that a notable formation of solid solutions does not occur; the same is true for the mixtures in the immediate vicinity of the SbJ_3. The

composition of the mixtures $SbJ_3 + J_2$ was each time determined by direct analysis, after recording the cooling-curve.

The value for the heat of fusion of pure iodine is, according to

Fig. 1.
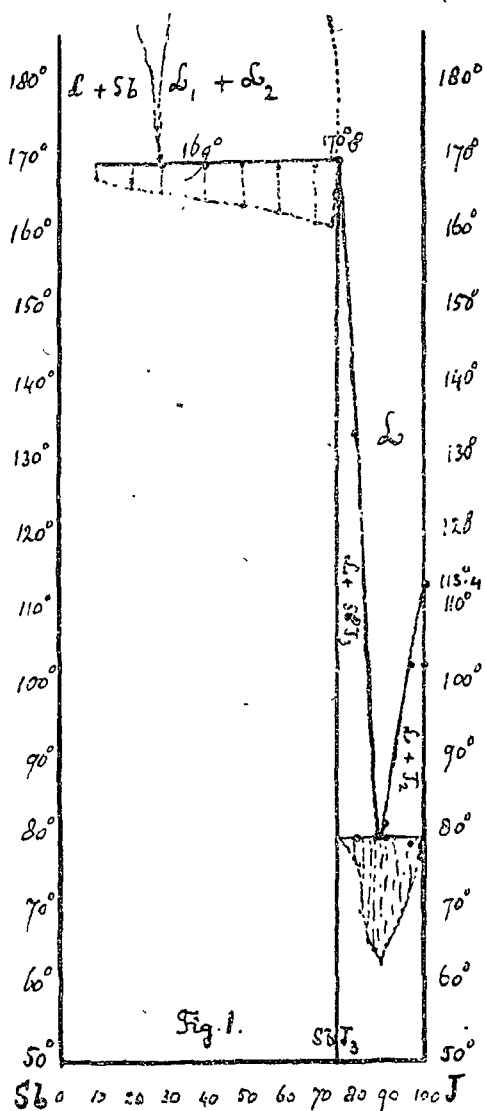
an old statement of PERSON (Jahresberichte 1847) 11.7 calories. From this we find for the molecular freezing-point-constant: 253°.2 C. TIMMERMANS (Journ. de Chim. phys. 4 (1906) 171) found a value of 252°.13 C. When this value is accepted we find, for the depression of the melting-point of the iodine by added SbJ_3, amounts which agree well with the temperature on the branch of the melting-point-line at the J-side.

Binary melting-point-line of As + J.

% by weight		% by atoms		Observed Temp.		Corr. Temp.		Duration of the effect in seconds (recalculated for a same number of atoms)	
As	J	As	J	Initial solidifying point	End solidifying point	Initial solidifying point	End solidifying point	Of lowest temp.	Of highest temp.
100	0	100	0		—	—	—	—	—
84.2	15.8	90	10	—	—	—	117.3	150	—
70.3	29.7	80	20	120.2	—	122.5	120.5	200	90
68.0	32.0	78.2	21.8	125.0	116.7	127.8	118.9	300	60
57.9	42.1	70	30	128.9	116.8	131.5	119.1	290	90
47.0	53.0	60	40	130.8	117.4	133.5	119.7	380	200
37.1	62.9	50	50	132.2	117.4	134.9	119.7	380	290
28.2	71.8	40	60	132.0	117.7	134.7	120.0	480	370
22.8	77.2	33.33	66.67	130.2	117.8	132.9	120.1	540	310
22.5	77.5	33.0	67.0	131.6	117.3	134.6	119.8	530	400
21.8	78.2	32.0	68.0	134.0	117.3	136.8	119.6	485	490
21.0	79.0	31.0	69.0	133.7	117.0	136.5	119.3	480	—
20.2	79.8	30.0	70.0	128.4	118.4	131.1	120.7	600	—
19.0	81.0	28.5	71.5	119.5	119.2	121.8	121.5	1100	—
18.3	81.7	27.5	72.5	126.4	118.8	128.9	121.2	640	—
17.2	82.8	26.0	74.0	134.8	112.2	137.6	114.3	160	—
16.45	83.55	25	75	138.1	—	140.7^5	—	—	—
16.3	83.7	24.8	75.2	137.2	70.4	139.9	71.1	70	—
15.9	84.1	24.2	75.8	132.5	72.2	134.9	72.9	250	—
13.2	86.8	20.5	79.5	109.7	71.8	111.4	72.4	740	—
9.4	90.6	14.9	85.1	79.5	72.2	80.3	72.9	1380	—
8.9	91.2	14.1	85.9	73	73	73.7^5	73.75	1500	—
7.8	92.2	12.5	87.5	75.8	72	76.6	72.75	1420	—
6.2	93.8	10	90	86.3	71.8	87.2	72.5	1220	—
3.0	97.0	5	95	101.3	71.3	102.6	72.0	850	—
0.3	99.7	0.5	99.5	110.0	68.0	111.7^5	—	110	—
0	100	0	100	112.1	—	113.3	—	—	—

Reversely, as SbJ_3 is not or but little dissociated in the molten mass, and assuming that iodine dissolves therein as molecules of J_2, we can calculate for the molecular heat of fusion of SbJ_3: 11 calories; it is, therefore about equal to that of iodine itself and K becomes here 357° C.

The melting temperature of 79° C. found by PENDLETON for SbJ_3 answers to the eutectic temperature and a composition of about 88.2 at. °/$_0$ of iodine. In this way nothing is noticed of a compound SbJ_5 or a compound Sb_2J_4.

I have also carried out experiments to ascertain, whether any of these compounds might perhaps form at a lower temperature, for instance in strong HJ-solutions, or as a double-iodide such as are known of SbJ_3 and $(NH_4)J$, BaJ_2 and RbJ [1]). Up till the present we have not succeeded in obtaining such compounds which would confirm the existence of the supposed iodides.

§ 3. *Arsenic and Jodine*. In a manner analogous to that given

Fig. 2.

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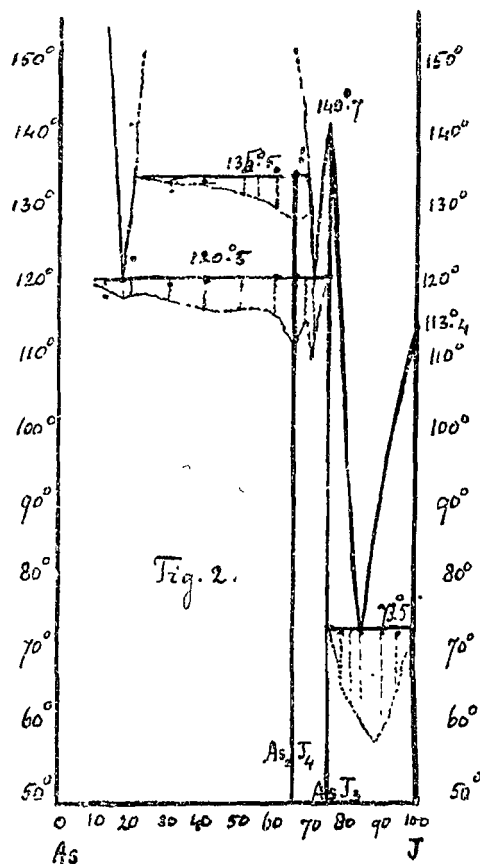
[1]) WHEELER. Zeits. f. anorg. Chem. 5. 253. (1894).

for the binary liquids of $Sb + J$, the system $As + J$ has also been investigated. The results are found in the subjoined table.

From these figures which are represented graphically in fig. 2, it follows that there is first of all a compound $As\,J_3$ stable at its melting point, and that this system exhibits in the main the peculiarities of the system $Sb + J$. The compound $As\,J_3$ melts at 140°,7 and is apparently but little dissociated in the liquid. Secondly, on closer examination of the eventual possibilities, there is no other possible interpretation of the data obtained but this one: from one of the two liquid layers a compound $As_2\,J_4$ is deposited which, therefore, has no *real* melting-point, but melts at 135°—136° to a complex of two non-miscible liquids. The one layer has a composition which corresponds nearly to that of $As_2\,J_4$, but contains a little more iodine. As the mean of various analyses (the J-determinations as $Ag\,J$ and the As-determinations according to the method of Gooch and Morris [1]) the composition of the upper layer was found to be: 79,4°/₀ of J and 21,6°/₀ of As, or in at. °/₀: 69.5 J and 30.5 As; the lower layer has a more varying composition so that the arsenic-content (70.8°/₀ by weight) is certainly a little too high. The temperature of the eutecticum at the arsenic-side *hardly* differs from that of the first eutecticum, so that it looks as if the eutectic temperature proceeds from 125° further towards the arsenic-side.

Although the whole construction of the diagram already points to the occurrence of a binary compound in compositions which are situated within the sphere of the two liquid layers, there are still more arguments in favour of the existence of As_2J_4. First of all the plainly perceptible heat-effects which occur in mixtures in the vicinity of 66—68 at. °/₀ of J and which appear in the figure as an apparent increase of the two-layer temperature: 135°,5. The course of the time-lines also confirms distinctly the above two explanations and makes the impression that we are dealing here again with a superposition of two time-effects.

It admits, moreover, of no doubt that the compound looked upon till now as As_2J_4 has really been nothing else but the upper layer present at 135°,5. According to Bamberger and Philipp a compound $As\,J_2$ is formed on melting 1 part of arsenic and 2 parts of iodine at 230° in sealed tubes for 7 or 8 hours. They state that "superfluous arsenic" is deposited in the tubes. On repeating their experiments, it appeared to us, that the product of fusion contained 79,73 °/₀ of J and in a second experiment 79,52 °/₀. As $As\,J_2$

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[1] Gooch and Morris, Zeits. f. anorg. Chem. **25**, 227 (1900).

requires 77,20 $^o/_o$ and AsJ_2 83,55 $^o/_o$ of iodine, the composition of the *product* lies between that of As_2J_4 and AsJ_3.

Afterwards we have tried, like B. and P. to obtain from the fused mass a compound As_2J_4 by means of carbon-disulphide.

Working in an atmosphere of CO_2, arsenic seemed to deposit; the solution exhibited definite colour-differences with those of pure AsJ_3, which compound on boiling with CS_2 always communicates a violet colour to the condensed liquid (owing to iodine split off.) The liquid was filtered, cooled in a CO_2-atmosphere with ice and salt and the crystals deposited were carefully dried at 50° in a CO_2-atmosphere. The analysis gave: 80,11 and 80,63 $^o/_o$ of iodine. These analyses prove that those otherwise homogeneous, crystals contain *more As* than AsJ_3 itself. These experiments were now repeated with fusions which contained *more As* to start with, in the hope to obtain perhaps in this way, by extraction with CS_2, crystals which contain still more *As* than the above named. I succeeded indeed in finding an arsenic-content of 19,23 $^o/_o$ and 19,58 $^o/_o$. The solution was cherry-red, the crystals were dark red, and therefore, of a different colour from those of AsJ_3.

A mixture of AsJ_3 with much finely powdered *As* was now boiled a long time with xylene (138°) in a current of CO_2. The filtered liquid was cooled rapidly, the mother-liquor evaporated in vacuo and the residue analysed. Found : 81.86 $^o/_o$, therefore again *more As* than corresponds with AsJ_3. This experiment proves plainly that a solution of AsJ_3 may take up a certain amount of *As* (otherwise insoluble in the solvent) to form a product containing more *As* than AsJ_3.

Previously, when recrystallising AsJ_3 from toluene, it had been found that the product obtained always contained more *As* than corresponds with the normal composition.

In diverse experiments were found : 83.16 $^o/_o$, 83.33 $^o/_o$, 83.05 $^o/_o$ of J ; after a single recrystallisation was found : 83.02 $^o/_o$, after a double recrystallisation 83.2 $^o/_o$, after a third time 82.77 $^o/_o$ of J. Pure AsJ_3 can only be obtained, when the substance is recrystallised from toluene, containing iodine. When subliming AsJ_3 in a current of CO_2 we also noticed an elimination of iodine, so that AsJ_3 belongs to those compounds which very readily dissociate, when in the state of vapour. From the melting diagram it would just appear that, at any rate in the *fused* AsJ_3, but comparatively little dissociation occurs.

Consequently we may well assume that a dissociation-equilibrium is present, expressed for instance by $2 AsJ_3 \rightleftarrows As_2J_4 + J_2$; and also that in the liquids, in which AsJ_3 has been brought together with

As, according to: $8\,AsJ_3 + As_4 \rightleftarrows 6\,As_2J_4$, $-6\,As_2J_4$ may be formed from $8\,AsJ_3$ and As_4 which latter reaction would then dominate the situation in the upper layer of the melt when heat is being abstracted. Up to the present I have not succeeded in obtaining the compound in a *pure* condition; but that it *does* exist can, in my opinion, no longer be doubted.

§ 4. Finally, we have collected data to ascertain the behaviour of AsJ_3 and SbJ_3, of AsJ_3 and PJ_3, also that of SbJ_3 and PJ_3
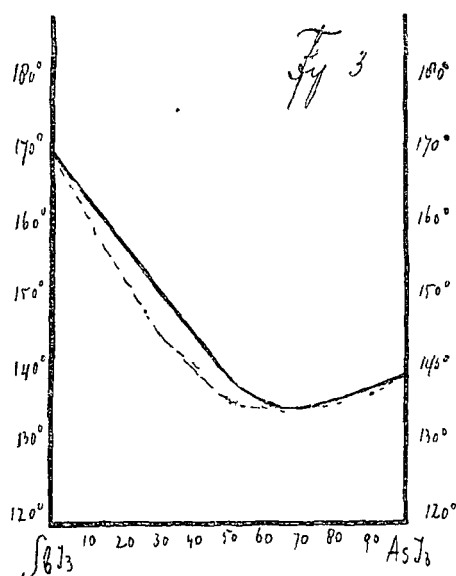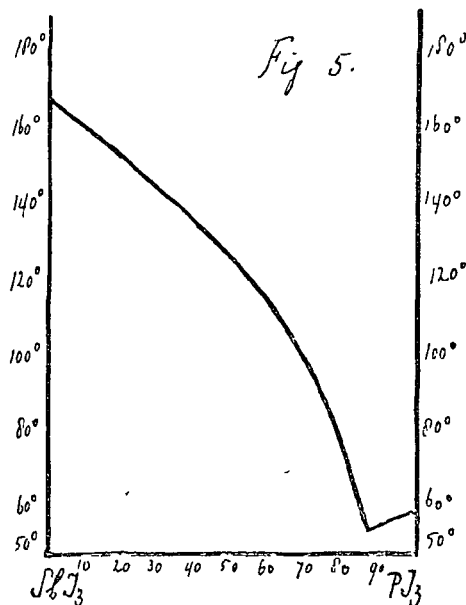

Binary melting-point-line of $AsJ_3 + SbJ_3$ (fig. 3).

Composition.		Initial Solidifying point.	End mp.	End Solidifying point.	Initial mp.
% by weight AsJ₃	mol. % AsJ₃	(corrected).		(corrected).	
0	0	170°.3	170.8	—	—
23.3	25	154°75	156.5	149	—
47.6	50	139.6	140.5	136	135
60.3	62.5	135.9	138.6	135.5	135
66.9	69	135.8⁵	138.4	135.5	135
73.2	75	136.3⁵	139.1	135	134
86.4	87.5	182.2	140.1	137	135.5
100.-	100.-	140.7⁵	—	—	—
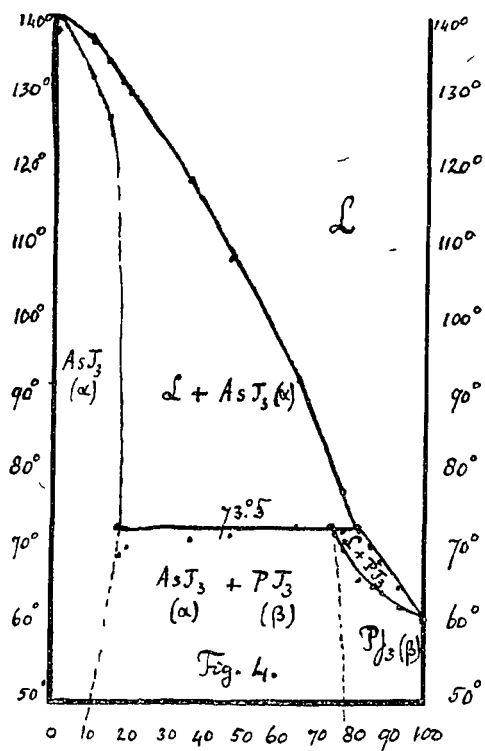
Binary melting-point-line of $AsJ_3 + PJ_3$ (fig. 4).

Composition in % by weight		Composition in mol. %		Observed Temp.			Observed Temp.			Duration in seconds: calculated on same number of molecules
PJ₃	AsJ₃	PJ₃	AsJ₃	Initial	Effect	End solidifying point	Initial	Effect	End solidifying point	
0	100	0	100	138.4°	—	—	141.5°	—	—	—
9.0	91.0	9.9	90.1	134.3	—	ca. 130°	137.1	—	ca.132.5	—
12.8	87.2	14.0	86.0	132.1	—	ca. 125°	134.9	—	ca.127	—
16.8	83.2	18.3	81.7	129.5	68.5	—	132.2	69.1	—	20
18.5	71.5	20.1	79.9	128.1	69.8	—	130.8	70.5	—	30
34.6	65.4	36.9	63.1	116.7	71.0	—	119.0	71.7	—	110
45.6	54.4	48.1	51.9	108.0	71.6	—	109.9	72.3	—	140
63.5	36.5	65.8	34.2	92.1	73.0	—	93.4	73.7	—	250
76.4	23.6	78.2	21.8	77.4	72.3	ca. 70	78.2	73.0	ca. 70.7	240
80.7	19.3	82.2	17.8	72.7	—	ca. 66	73.4	—	ca. 66.5	—
84.6	15.4	85.8	14.2	70.2	—	ca. 65	70.9	—	ca. 65.5	—
87.0	13.0	88.1	11.9	68.1	—	ca. 64	68.75	—	ca. 64.5	—
92.2	7.8	92.9	7.1	64.9	—	ca. 62	65.5	—	ca. 62.5	—
100.-	0.-	100.-	0	60.4	—	—	61.0	—	—	—

in regard to each other. The results of the determination of the binary melting-point-lines are represented in the subjoined tables and in the fig. 3, 4, and 5.

Binary melting-point-line of $SbJ_3 + PJ_3$ (fig. 5).

Composition in % by weight		Composition in Mol. %		Observed Temperature.		Observed Temperature.		Duration of the second effect in sec. (calculated on a same number of mols).
P J₃	Sb J₃	P J₃	Sb J₃	Initial solidifying point	End solidifying point	Initial solidifying point	End solidifying point	
0	100	0	100	167.1	—	170.3	—	—
2.7	97.3	3.2	96.8	164.3	—	168.0	—	—
8.6	.91.4	10.3	89.7	159.1	52.8	162.5⁵	53.2⁵	100
10.1	89.9	12.1	87.9	157.7	52.5	161.5	52.9⁵	—
35.1	64.9	39.7	60.3	135.4	55.8⁵	138.0⁵	56.3	360
60.4	39.6	65.0	35.0	108.2	55.8⁵	110.1⁵	56.3	740
83.3	16.7	85.9	14.1	57.9	55.7	58.3⁵	56.1⁵	900
92.2	7.8	93.5	6.5	—	57.2		57.6⁵	920
100	0	100	0	60.4	—	61.0	—	—

Fig. 4 needs no further comment: PJ_3 and AsJ_3 form an *isodi-morphous mixing series*, with a transition-point at 73°.5 C.

The liquid coexisting with both mixed crystals, contains about 82 mol. °/₀ PJ_3, whereas the two mixed crystals have at that tempe-

rature a composition of about 75 mol. $^o/_o$ of PJ_3 and 18 mol. $^o/_o$ of PJ_3, respectively; the solidus-line at the side of the AsJ_3 is so steep, that only a few points could be indicated with some degree of accuracy.

The crystallographic measurements of PJ_3 and AsJ_3 left, up to the present, some doubt as to the isomorphism of the two compounds. According to Nordenskjöld [1]) PJ_3 is hexagonal (or trigonal ?) with $a : c = 1 : 1$, 1009 with $\{0001\}$ and $\{10\bar{1}0\}$, when recrystallised from CS_2, or with $\{10\bar{1}0\}$, $\{0001\}$ and $\{10\bar{1}2\}$ from the melt; twins according to $\{11\bar{2}2\}$.

On the other hand, AsJ_3, according to Friedländer [2]), is trigonal with $a : c = 1,2998$ with base $\{211\}$, $\{110\}$, 411} and complete cleavage parallel $\{111\}$.

These data indeed do not lead without further confirmation to the assumption of an isomorphism. The melting-experiments now prove, that AsJ_3 and PJ_3 do possess indeed a *different* symmetry ; it is not improbable that each of the compounds still exhibits a metastable modification, which corresponds with the more stable form of the other substance.

The case represented in fig. 3 $(AJ_3 + SbJ_3)$ also leaves but little doubt. We have here an isomorphous mixing series with a minimal -temperature.

SbJ_3 [3]) is trimorphous; the rhombic (yellowish-green) as well as the monoclinic (greenish-yellow) modification, are however metastable, monotropous forms are only obtainable under very particular conditions. On the other hand, the mixed crystals are trigonal and coloured red, just like the more stable, trigonal, red modification of SbJ_3.

The trigonal SbJ_3 shows $\{111\}$, $\{100\}$ and $\{110\}$; the angles found by Cooke, are, however, not correct as shown by Negri (Rivista di Min. Crist. Ital. Padua **9**. 43. (1891)). For the angle a he finds $50°40'$ whilst that for AsJ_3 was determined as $51°20'$.

All this, in connection with the melting-point-line found, points sufficiently to an actually existing isomorphism between the two compounds.

The case of fig. 5 $(SbJ_3 + PJ_3)$ points to an ordinary mixing series with an eutectic temperature at $56°$.

Whereas in the case of PJ_3 and AsJ_3, there was already present an uninterupted mixing series with a large hiatus, the miscibility in

[1]) Nordenskjöld, Z. f. Krist. **3**, 214 (1897).

[2]) Friedländer, Bihang K. Svenska Vet. Acad. Stockholm (1874).

[3]) Cooke, Proc. Amer. Acad. **13**. 74. (1877); Abstract Z. f. Krist. **2**, 634.

the case of PJ, and SbJ_3 has completely disappeared, or at least been limited to concentrations in immediate proximity to the axes. All this is systematically connected with the steadily increasing distance between the elements phosphorus, arsenic, and antimony, in regard to each other.

November, 1911. *Inorg. Chem. Lab. University. Groningen.*

Physics. — *"The Thermomagnetic Properties of Elements."* By Mr. Morris Owen. (Communicated by Prof. H. E. J. G. du Bois).

A short account was given in a recent communication [1]) of experiments upon 43 elements at ordinary and high temperatures. The present investigation was undertaken with the idea of increasing the number of elements to be experimented upon, and also of finding the effects of low temperatures upon the magnetic susceptibility.

I. *Experimental Arrangement.*

This has already been described in detail. It is only necessary here to mention that the method of Curie and previous investigators was employed with one exception, viz. that the investigated substance was not placed at that point of the magnetic field where $\mathfrak{H}_x \, \partial\mathfrak{H}_x/\partial y$ is a maximum.[2]) This was due to the fact that about this point the field-variation can be quite considerable, especially in the case of a substance of comparatively somewhat large dimensions. In fixing on a point at which to work at more stress was laid upon the attainment of a maximum field, because the iron impurities then exert a proportionally smaller detrimental influence.

Three different adjustments of the apparatus were employed differing only in the length and thickness of the suspending silver wire of the torsion balance, and the inclination of the axes and the distance apart of the two cores of the electromagnet. The latest large type model of the du Bois electromagnet, recently described in these Proceedings, was placed at my disposal. The whole arrangement for ordinary temperature work was much more sensitive than any used previously.

The sensitiveness of the torsion balance could be varied: the directive force per unit degree torsion was measured in the ordinary way by means of applied additional moments of inertia.

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1) H. du Bois and K. Honda, These Proc. XII p. 596.
3) K. Honda, Ann. d. Physik **32**, p. 1027, 1910, Fig. 1.

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